Palaeoanthropological Investigations of the Thai-American Expedition in Northern Thailand (1978-1980): An Interim Report

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IN THE FIRST HALF of this century, explorations and discoveries in Java indicated that hominids had occupied Island Southeast Asia during the early Pleistocene (Koenigswald 1935, 1936). Work during the last few decades has not only succeeded in increasing the number of known hominid specimens from Java, but has also established a radiometric framework which indicates that early species of *Homo* had reached Southeast Asia at least as early as the Lower Pleistocene (Koenigswald 1956; Jacob and Curtis 1971; Jacob 1972, 1973, 1975). While the taxonomic status of many of the hominid specimens is an issue of current debate, certain biogeographic aspects of the history of these hominids may be deduced with a fair amount of certainty. The fact that the then-exposed Chao Phyra River plain and Sunda Shelf served as a major dispersal route for hominids is suggested not only by fossil hominids themselves but also by the distribution of living and fossil mammals in Java and Mainland Southeast Asia (Colbert and Hooijer 1953; De Terra 1943; Lekagul and McNeely 1977).

Recent discoveries in the southernmost province of China have also greatly expanded our knowledge of the early Pleistocene distribution of Asian hominids. At Yuanmou, Yunnan (some 700 km from Chiangwat Chiang Mai), two upper

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central incisors assignable to *Homo erectus* have been accorded an age of 1.63–1.64 million years on the basis of faunal and palaeomagnetic studies (Hu 1973, Li et al. 1976, Pope 1977). In addition to these dental specimens, several artifacts and possibly charred bones have also been recovered in the same stratum (Pan 1977). Other hominids from the karst areas of south and central China also document the presence of hominids in China during the Middle and Lower Pleistocene (Gao 1975).

In spite of the recovery of a number of hominid fossils from East and Island Southeast Asia, a number of taxonomic and biogeographic questions about the evolutionary history of the Plio-Pleistocene Asian Hominidae remain unanswered. Primary questions concern the chronological position of and anatomical relationships between the East African and tropical Asian hominids (Javanese and South Chinese materials). Tobias and Koenigswald (1964) have pointed out close anatomical similarities between *"Homo habilis"* and *Homo modjokertensis*. Hu (1973) and Gao (1975) have advanced similar conclusions about the close affinities of early Pleistocene Chinese specimens recently recovered from South and central China. Koenigswald (1957, 1975) has further suggested that two lineages of hominids, a robust lineage *(Hemanthropus, Meganthropus)* and a gracile lineage, *(Homo)* were synchronic and sympatric in Asia as they were in Africa. As provocative as such suggestions are, they are unfortunately based on the rather limited hominid fossil record in Asia. The question of the existence of two separate but contemporaneous lineages of hominids in Asia has important implications for theories concerning the emergence of the genus *Homo*. Theories concerning the emergence and distribution of early species of *Homo* can be divided into those postulating a specific center of origin (usually Africa) and those postulating a "generalized tract" of interbreeding populations which were distributed across the Old World tropics. Whichever model is adjudged to be most probable, the question of the timing and antiquity of Plio-Pleistocene hominid dispersal still remains. Knowledge of the nature and range of ecological adaptations of these early hominids and their relation to patterns of mammalian migration and dispersal is also requisite to an understanding of the Plio-Pleistocene Hominidae. In the absence of additional extra-African evidence, answers to these important questions will remain necessarily constrained.

Several factors underscore the importance of pursuing palaeoanthropological researches in Thailand. Not only is northern Thailand favorably situated in the geographical center of the known distribution of the majority of Plio-Pleistocene Asian Hominidae (between South China and Java), but it is also located in the center of the past and present major migration routes of Asian mammals (Colbert and Hooijer 1953; De Terra 1943; Kahlke 1961; Pei 1957*a*, 1957*b*, 1958). Chiangwat (Province) Chiang Mai is located at the northern end of the Chao Phyra River basin, which is continuous with the now-submerged Sunda Shelf. Figure 1 outlines the postulated migration routes for the known distribution of the *"Stegodon-Ailuropoda* faunal complex" (the "Siva-Malayan and Sino-Malayan fauna" of authors). The association of this fauna with Asian hominoids *(Homo, Gigantopithecus, Pongo,* and *Hylobates)* in China, Vietnam, and Java suggests the high probability of recovering new fossil materials from the geographic center of this faunal complex. The cosmopolitan nature of the modern Thai mammalian fauna also indicates that Thailand is located at the "crossroads" of Asian dispersal routes (Lekagul and McNeely 1977; see Table 1).

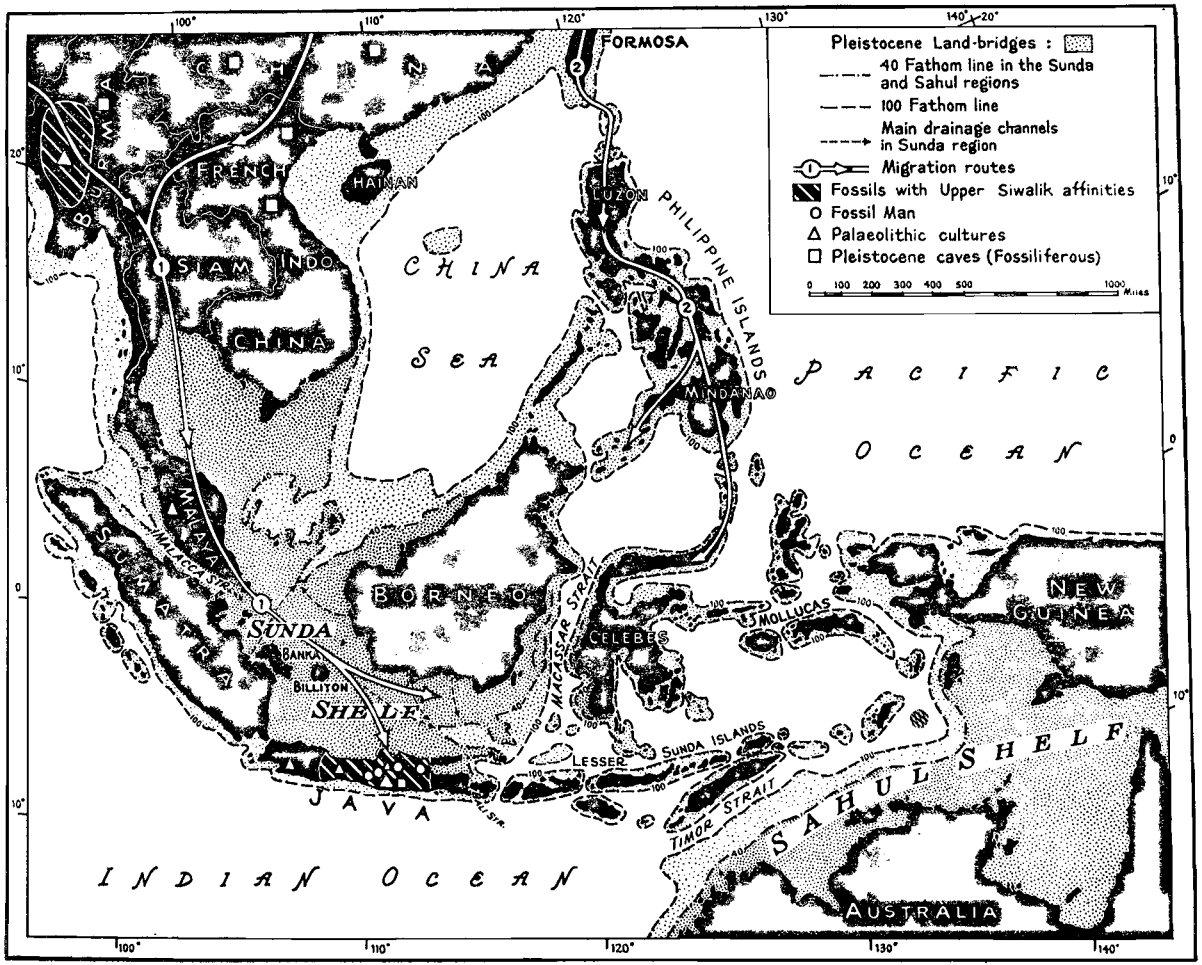


Fig. 1 Pleistocene migration routes (from De Terra 1943).

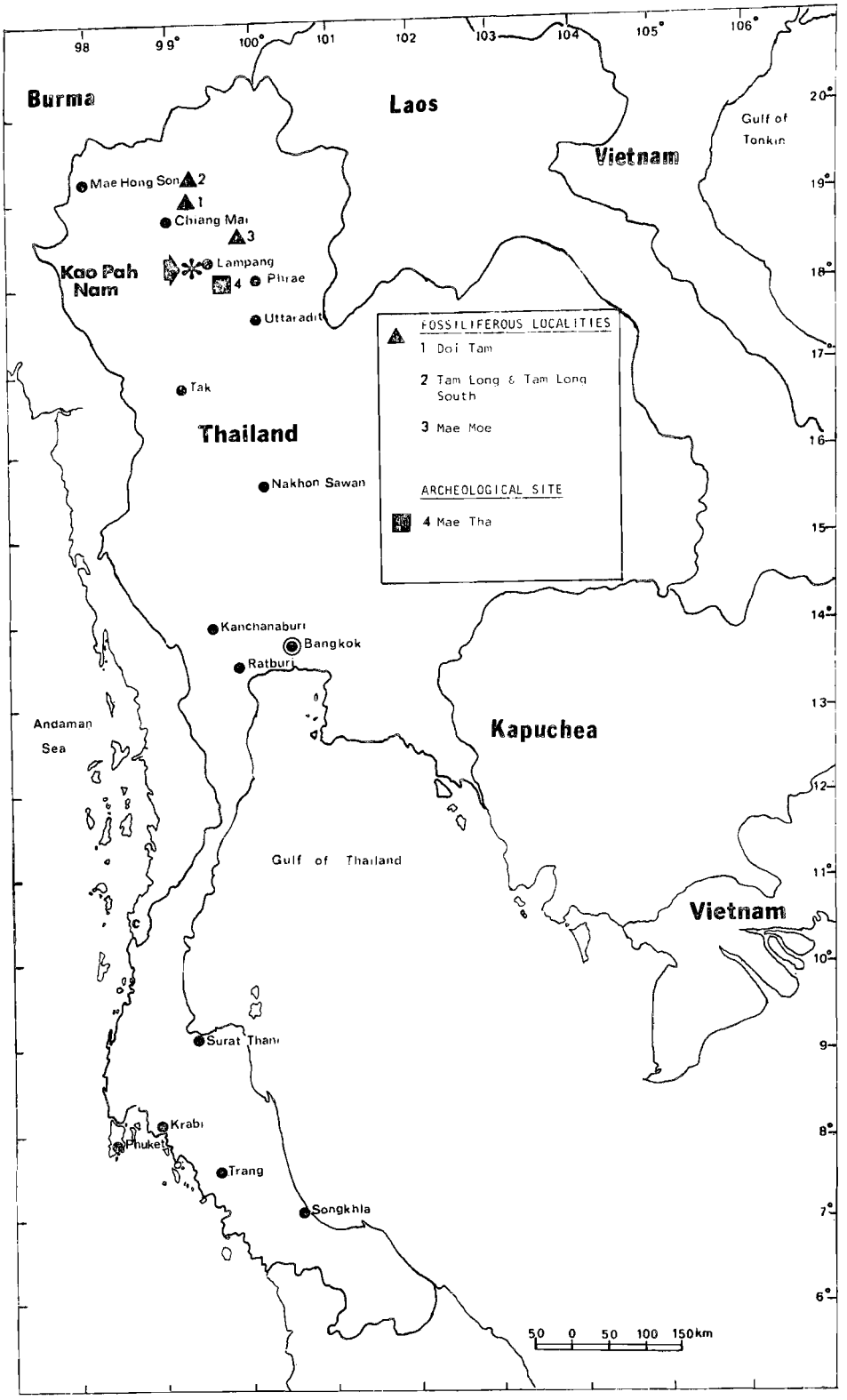


Fig. 2 Fossiliferous localities and archaeological sites in northern Thailand.

TABLE 1. ZOOGEOGRAPHICAL AFFINITIES OF THAI MAMMALS*

REGION OR SUBREGION	NUMBER OF SPECIES	PERCENTAGE OF TOTAL
Sundaic	69	27.7
Indochinese	57	22.9
Indian, Indochinese	28	11.2
Sundaic, Indochinese	36	14.5
Oriental	20	8.0
Palaearctic	15	6.0
Palaearctic, Oriental	4	1.6
Palaearctic, Indochinese, Sundaic	4	1.6
Palaearctic, Indochinese	5	2.0
Others	11	4.4
Totals:	249	99.9

* From Lekagul and McNeely (1977).

To these considerations may be added the fact that the geological setting of north Thailand is highly conducive to the preservation of fossil faunas. Not only are limestone karst features (i.e., caves, fissures, and sinkholes) abundant in Chiangwat Chiang Mai, but a number of fluvio-lacustrine sequences (including late Tertiary fossiliferous lignite beds) also occur in proximity to the karst areas. One of these localities (Mae Tha; see Fig. 2) has recently yielded some of the earlier known stone tools in Mainland Southeast Asia (Sørensen 1976) and has been assigned an age of greater than .69 mya on the basis of palaeomagnetic studies (Macdonald and Macdonald 1977) conducted on an overlying basalt flow. During the course of fieldwork conducted from 1978 to 1980, several new fossiliferous localities were discovered, thus confirming the opinion that Chiangwat Chiang Mai is an excellent area in which to pursue researches and recover important new fossil materials.

1978 FIELD SEASON

From January through April, 1978, in conjunction with Malai Liangchareon, Pinit Kulasing, and Supaporn Nakabanlang, and under the auspices of the Royal Thai National Research Council and the Department of Mineral Resources, we visited over forty caves and fissures within a 100-km radius of Chiangwat (Province), Chiang Mai, northern Thailand. (It is estimated that this represents something less than 10 percent of accessible fossiliferous localities in the area.) Ten fossiliferous karst caves were located and small samples were taken from three of the localities (see Fig. 2) and returned to the University of California for palaeontological, palynological, and sedimentological studies which are now being conducted by G. Pope and D. E. Savage; M. Liangchareon; and P. Kulasing and G. Pope, respectively. Preliminary conclusions indicate that each of the localities is of a different age and that they may range from early to late Pleistocene. Currently, these age estimates are based primarily on the elevation and geomorphology of the localities. These estimates are also consistent with preliminary observations on the

degree of fossilization of the mammalian materials and the degree of consolidation of the breccia matrix in which the fossils occur.

Karst caves of the Chiang Mai area occur at different elevations (ranging from approximately 400 to 850 m above sea level) in the massive Permian limestone of the Ratburi Group. Most of the Permian outcrops are folded, and local recrystallization is evident. Genesis of caves and fissures appears to be the result of the formation of solution cavities in fault and fracture zones. Caves were observed to exhibit a characteristic morphology which correlated well with their elevation above the immediate base level of local outcrops. As a general rule, most of the caves occur nearly perpendicular to the strike of north-south running ridges ranging from about 25 to 200 m in height above the local valley floor.

The first locality sampled (Plate I) is one of 33 caves (according to local reports from villagers) which occur on Doi Tam (Mountain of Caves), located approximately 18 km from Sangkhempang. The locality is situated at 18° 47′ N × 99° 14′ E. The fissure is located 3 m west of the opening to a large sinkhole, Tam Wiang (City Cave). The base of the measured portion of the section is 448 m above sea level and approximately 85 m above the base of the karst tower. Only the upper 10 m of the fissure were measured and sampled, since the remainder (the lower section) was covered by talus slope deposits.

Fossils occur throughout the 10 m of measured section exposed in a vertical face on the west side of a fissure 3.5 m in width. The breccia is well cemented and ranges from white to bright orange in color. Angular limestone blocks, flowstone fragments, and fragments of stalagtites and stalagmites occur in "pockets" throughout the face of the exposure. Pockets of phosphate, presumably representing bat guano deposits, also occur at all levels of the exposure. Stratification is only readily apparent at one level (2 m above the base) and is indicated by a layer of clay balls, small limestone fragments, and bone fragments. Two vertebrae fragments, tentatively identified as Bovidae, were recovered from this level.

Fossil materials were quarried in breccia blocks and sent to the University of California at Berkeley for preparation and study. Preliminary identifications include Megachiroptera, Muridae, Tragulidae, Cervidae, *Muntiacus,* and *Naemorhedus.* It should be noted that only those fossils which were exposed and in danger of being lost during the next rainy season were collected. Detailed identifications and biostratigraphic comparisons will be available later.

The second and third localities sampled occur approximately 95 km north of the town of Chiang Mai (18° 48′ N × 99° 46′ E) and consist of two fissure fills situated on the southwest cliff face of a karst tower approximately 60 m high. The first of these occurs approximately 30 m above the base of the tower. In this locality, which is called Tam Long (Coffin Cave), a "vein" of red fossiliferous breccia ranging from 2 to .5 m in width was located approximately 3.5 m inside the mouth of the fissure. The vein extends back another 12 m into the fissure. The same method and criteria for collection as used at Doi Tam were used here. Cervids were identified in the field.

The third locality occurs approximately 30 m south of the second at an elevation of 25 m above the base of the cliff and is referred to as Tam Long South. The locality consists of a fissure fill with approximately 3 m of fossiliferous dark brown

breccia exposed in a vertical face. The breccia is noticeably less consolidated than that of Tam Long. Several cervid fragments were immediately identified in the field.

THE 1979 AND 1980 FIELD SEASON: EXCAVATIONS AT KAO PAH NAM

In the 1979 and 1980 field season, the joint Thai-American research effort was expanded to include D. W. Frayer, from the University of Kansas, and R. N. Dreiman, from the University of California at Berkeley. The focus of research also shifted from Chiang Mai Province to the province of Lampang. The resulting field seasons brought to light what may be the oldest hominid activity site in Mainland Southeast Asia.

Kao Pah Nam (Forest Thorn Hill) is a highly dissected and weathered limestone karst tower of Permian age (Piaysin 1972) which outcrops about .1 km from the Mae Nam Wang (River Wang) and about 2 km from the village of Ban Hat Pu Dai in the province of Lampang (99° 20′ E × 18° 2′ N) (see Fig. 2). The occurrence of fossils at Kao Pah Nam was first brought to the expedition's attention by Achan Sujit of the Department of Geological Sciences, Chiang Mai University.

Geology of Kao Pah Nam

Fossils occur in a range of sedimentological contexts resulting from the accumulation of bones in what is interpreted as a palaeo-cave or palaeo-rockshelter. Fossils occur in limestone breccia and in an overlying and sometimes underlying soil zone whose genesis is somewhat problematical at present. The fossiliferous sediments are situated between two weathered outcrops of limestone (see Figs. 3 and 4; Plate II). The northern limestone ridge dips at approximately 30° and strikes due west for a distance of 30 m. This ridge delineates the northern border of an estimated 45 m^2 of exposed breccia that were investigated.

Although sedimentological and chemical analyses of the Kao Pah Nam sediments are being carried out, geological conclusions as to the genesis of these complex sediments are still at a preliminary stage. It is possible, however, to make certain useful observations which shed light on the origin of these sediments.

Fossils occur in all types of sediments with seemingly equal frequency; that is, no noticeable differences in taxonomic frequency between the soil deposits and the hard breccia can be observed. The degree of fossilization varies considerably from slightly to well mineralized bones, but does not seem to be a function of the surrounding matrix of the fossils.

Soil Zone

This zone ranges in thickness from a few centimeters to several meters. Its true extent is difficult to determine since much of it has been removed and disturbed by the regular phosphate mining of local villagers (now halted under government orders). The soil is very dark and humic. Organic matter, including roots, twigs, rodent bones, and leaves, is common near the current surface but tends to decrease in frequency with depth. Rodent and root activity is apparent in this zone. Weathered limestone and fresh limestone (not showing a characteristic orange on white patination) rocks generally less than .25 m in diameter are also present. In the

uppermost section a small "pocket" containing pottery and polished axes was encountered but left virtually undisturbed.

Soil Pockets

These are recognized and defined as pockets of soil "wells" or "trenches" (ranging from a few centimeters to over 2 m in depth) which occur in the underlying breccia (Plate III). The walls of these pockets were almost always observed to exhibit vesicular breccia (see Plate III). Vesicles range from under a centimeter to about 10 cm in diameter. These pockets were also highly fossiliferous in many instances. Many bones recovered from these pockets exhibited adhering brecciated

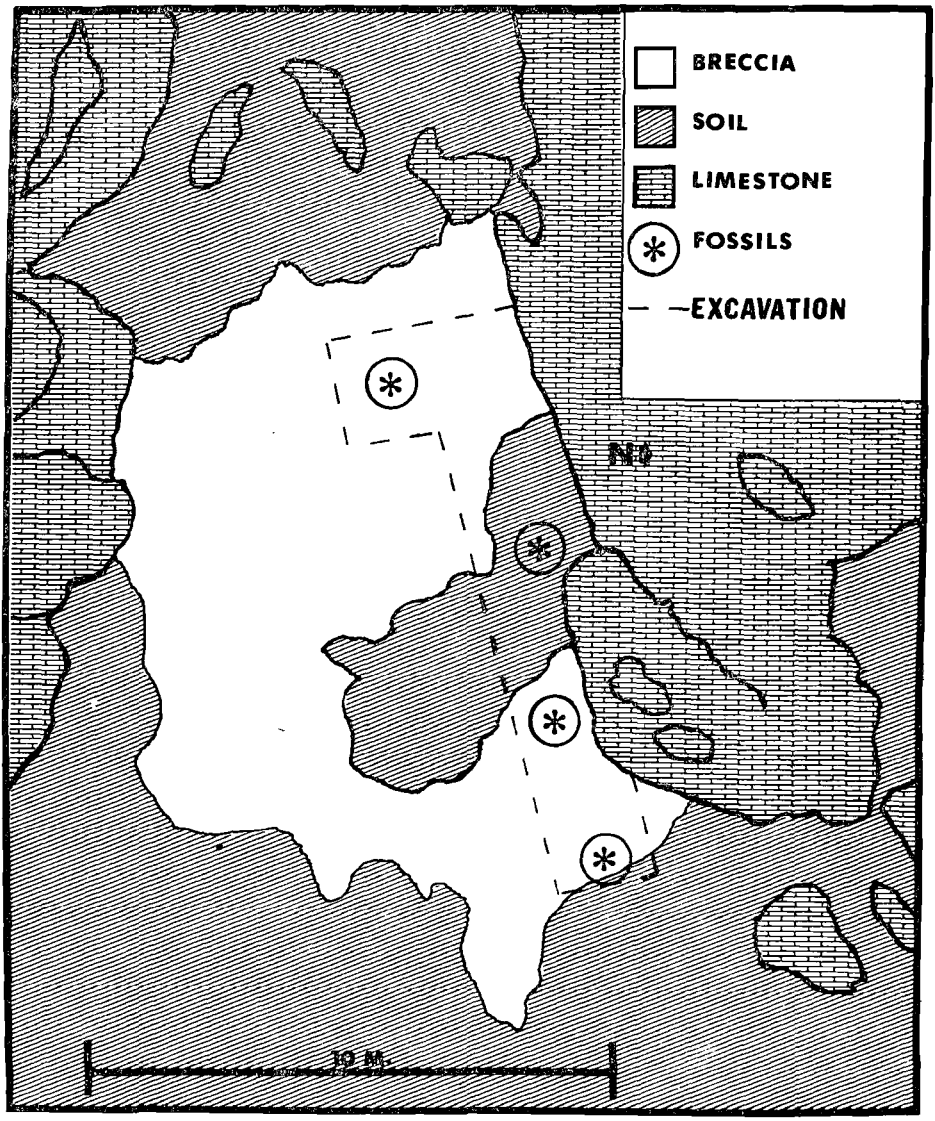


Fig. 3 Aerial view of Kao Pah Nam.

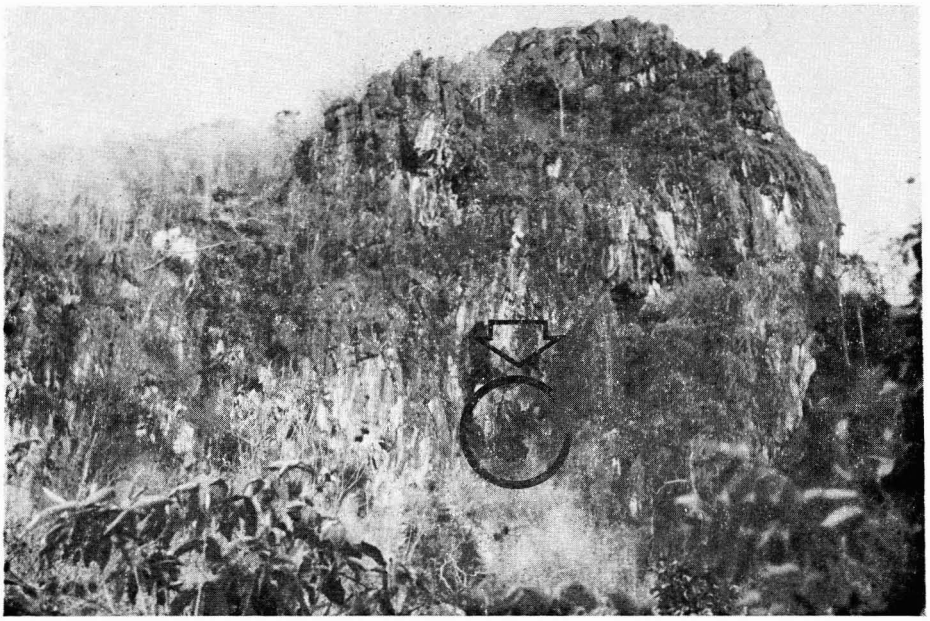


Plate I Southern face of karst tower showing Doi Tam Fissure complex (circle and arrow).

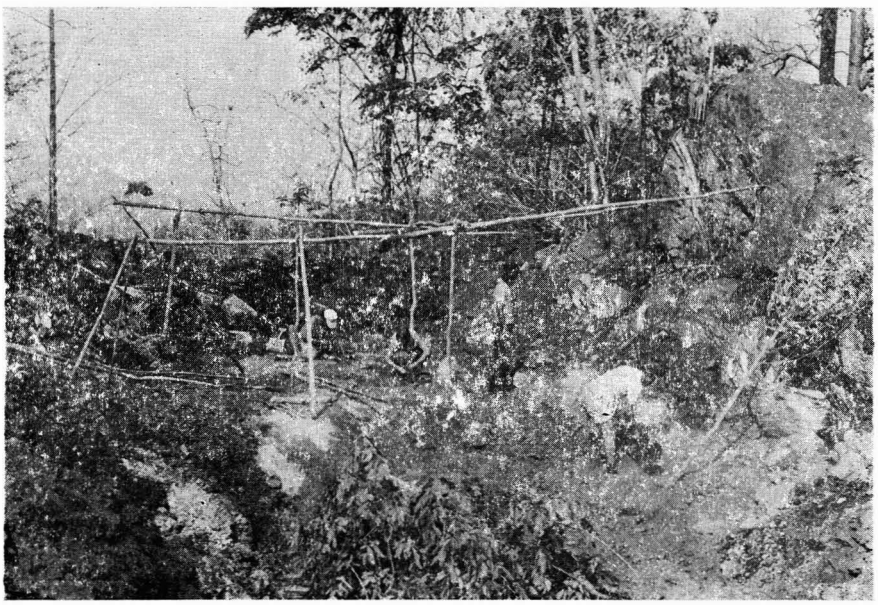


Plate II View of the Kao Pah Nam Deposits looking west with limestone ridge exposed on the right.

Plate III Exposure of the vesicular breccia surrounding a "soil pocket" (arrow).

Plate IV Close-up of vesicular breccia showing the development of soil in vesicles.

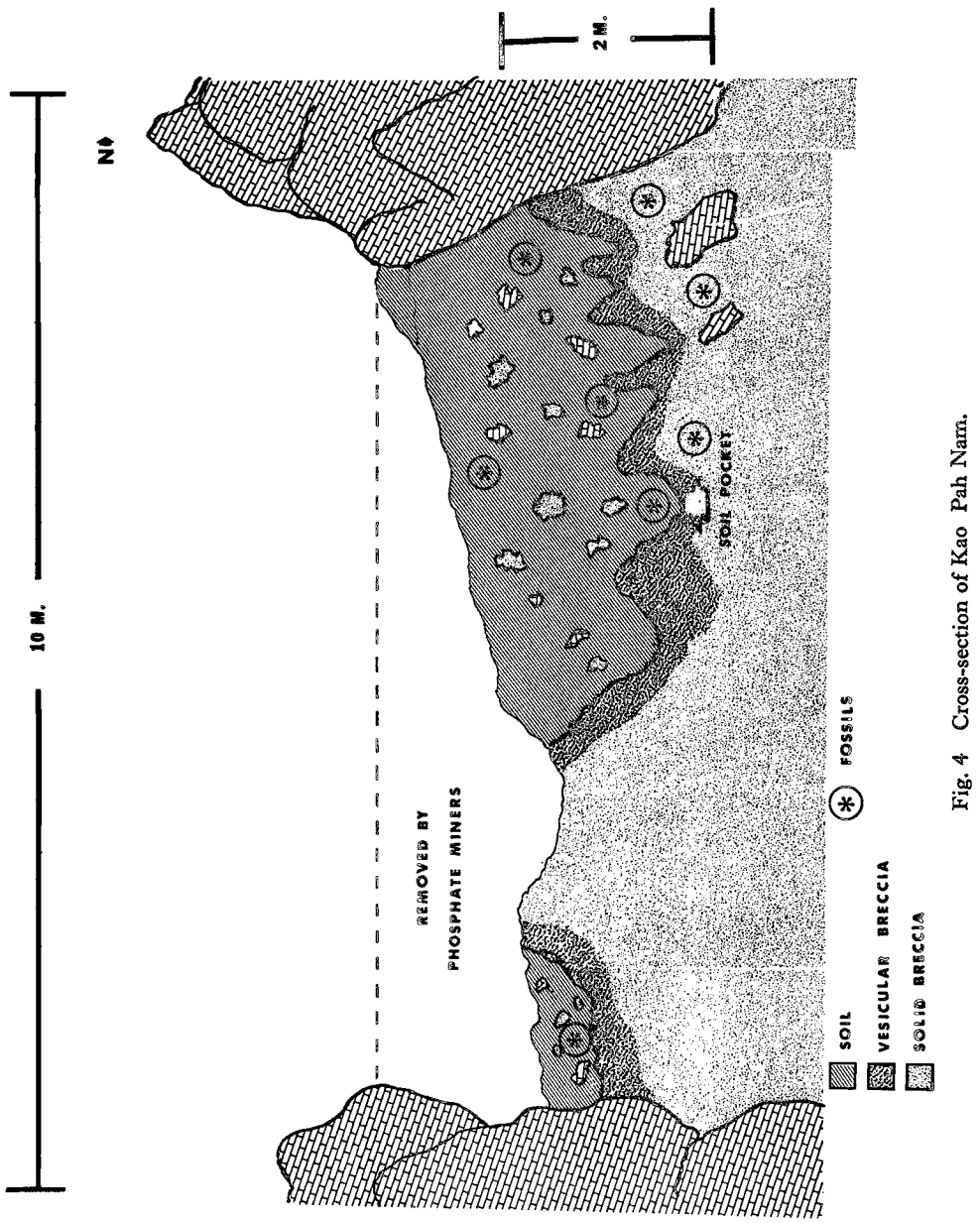


Fig. 4 Cross-section of Kao Pah Nam.

matrix. In some cases bones were observed to be protruding from the breccia into the pockets. Living roots were also common in both the soil and vesicular breccia which occurs on the walls of the pocket.

Vesicular Breccia (Plate IV)

As has been mentioned previously, this type of presumably weathered breccia occurs both above underlying well-consolidated breccia and on the "walls" of soil pockets. The vesicles in this breccia are often filled with roots and soil. The color is extremely varied, ranging from pink to dark brown. The mottled breccia ranges in thickness from a few centimeters to approximately .25 m.

Well-Consolidated or "Solid" Breccia

Like the other sediments of Kao Pah Nam, the well-consolidated breccia is fossiliferous. It ranges in color from white, yellow, brown, and orange to red. Some sections are highly phosphoric. The breccia is well to poorly sorted. Poorly sorted samples characteristically included fossils and angular limestone chunks in a fine-grained matrix held together by calcite cement, including crystals and a few flowstone fragments; small quartz pebbles also occur infrequently. No basalt whatsoever was discovered in the breccia or any of the other sediments at Kao Pah Nam. Preliminary field observations indicate that the abundance of bones in the breccia was inversely related to phosphate content of the breccia. This may suggest that the phosphate originates as the result of the disintegration of bones. The breccia was observed to be at least 2 m thick in places, but its true depth is probably much greater. No sand lenses or rounded cobbles were observed in the breccia. Another somewhat surprising feature of the deposits is the paucity of travertine and flowstone features usually abundant in breccia recovered from karst caves and fissures.

The Fauna of Kao Pah Nam: Deposition and Preservation of Kao Pah Nam Fossils

Bones are generally gnawed and broken. Additionally, some exhibit extensive weathering while others show very little decomposition. Matrix of both soil and breccia is present in medular cavities and weathering cracks of bones. No articulated limb bones were observed. The most complete bones were large bovid and *Crocuta* cf. *ultima* post crania. In contrast to many other fossiliferous cave breccias observed by the expedition in northern Thailand during the last two years, there is a surprising lack of small mammals (especially chiroptera and small rodents) at Kao Pah Nam. Besides mammals, chelonia and snakes are abundant (see Table 2).

TABLE 2. PRELIMINARY LIST OF TAXA FROM KAO PAH NAM

Reptilia	Primates	Artiodactyla
Chelonia	*?Pongo* sp.	*Hippopotamus* sp.
Rodentia	Carnivora	*Cervus eldi*
Hystrix sp.	*Crocuta* sp.	*Cervus* sp.
	Panthera tigris	*Bos* cf. *gaurus*

The presence of *Crocuta* sp., *Panthera tigris, Hystrix* sp., and apparently hominids (Plates V*a,b*, VI, VII) suggests that one or all of these agents were at least partly responsible for the accumulation of bones at Kao Pah Nam. An alternative interpretation may indicate that deposition of the Kao Pah Nam fauna may be the result of animals falling into a fissure. The lack of coarse clastics other than limestone, the absence of sand lenses, and the abundance of calcitic minerals suggest that the depositioned environment was a low energy one involving little water transport of bone. The paucity of small mammals relative to other Thai caves may be due to one of two factors:

1. Kao Pah Nam fossils accumulated in a relatively open "rockshelter" or at the mouth of a cave where bats were less numerous. The ubiquity of a snail genus which usually occupies cool shady cave mouths in Thailand supports this possibility.

2. The lack of small mammals may be a preservational bias. Small bones may be easily dissolved by the action of ground water. The genesis of the phosphate deposits is currently under study at Chiang Mai University. It is already apparent, however, that coprolite casts from bats and other small mammals are not as abundant here as they are in other cave phosphate deposits in Thailand.

The occurrence of fossils in soil pockets is currently interpreted as the result of fossils which have been weathered out of the breccia through the actions of roots and acidic ground water. The planned comparison between nonsoluble minerals of the breccia and soil will be helpful in allowing us to determine the origin of the soil.

Artifacts

Artifacts are dealt with here in a preliminary way and the illustrations presented in this report are only field photographs included as a means of providing an introduction to the nature of the Kao Pah Nam evidence. Detailed description and analysis of all the Kao Pah Nam artifacts will appear at a later time.

Seven nonlimestone rocks were recovered from a small soil pocket at Kao Pah Nam. These rocks are currently interpreted as modified manuports. Additionally, a partial scapula (?) of a large (?) bovine that seems to have been cut or sawed was also recovered.

KPNA-1 (Plate VIII) is a split quartzite river cobble measuring 89 cm × 65 cm. At least one percussion scar is observable on the break edge. Wear striations are not apparent. The artifact shows no obvious signs of retouching. The relatively sharp edges and the lack of wear striations suggest that KPNA-1 is an unutilized flake.

KPNA-2 (Plate IX) is a bipolar-flaked cobble of indurated sandstone which is trapezoidal in cross section. The cobble measures 93 cm × 60 cm. It closely resembles an artifact from Zhoukoudian also manufactured of indurated sandstone.

KPNA-3 is a small chert flake 3 cm × 1 cm. Rings of percussion are in evidence. Possible wear chips occur along one edge of the flake. One surface appears to represent the cortex of the original cobble.

The bone shown in Plate X appears to have been "chopped" or "sawed" in order to produce a flat surface which occurs at a right angle to the long axis of the bone. The flat surface is slightly pitted, a condition which may have resulted from

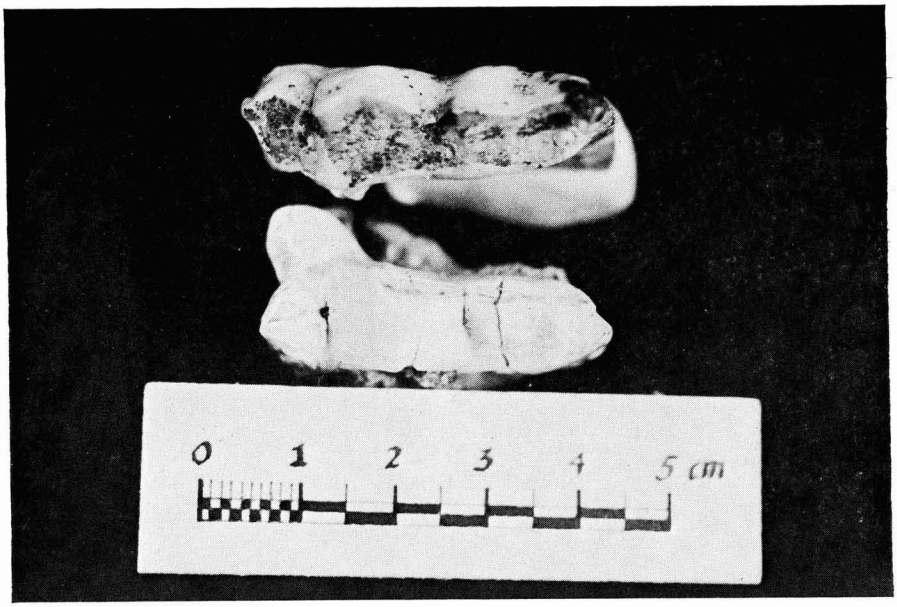
pounding. Gnaw marks of rodents are also observable on the bone but do not resemble the flat edge. This surface is very distinct in comparison with the carnivore gnaw marks and break planes observed on most of the bone in the Kao Pah Nam deposits.

The fact that the only extraneous rocks from Kao Pah Nam over a few centimeters in diameter all appear to show evidence of modification seems highly significant. Kao Pah Nam sits on a small hill well above the Mae Nam Wang (river), which was probably the source of the cobbles. No sign of river or stream activity (i.e., rounded cobbles, sand lenses, or erosion planes) is observable in the Kao Pah Nam deposits. All these materials can be found in the current stream bed of the river. Interestingly, the few basalt cobbles which were found at the site all occur toward the top of the soil zone. This may indicate that the deposition of the Kao Pah Nam breccia deposits preceded the deposition of the Lampang basalt flow. We could not locate any alternative source for these rocks since all of the higher surrounding rocks are limestone. We believe that this argues strongly for the interpretation of the Kao Pah Nam materials as manuports—probably tools. Sørensen (1976) notes that quartzite and quartzitic sandstone are the materials preferred in other Lower Palaeolithic sites in northern Thailand. We believe further that the small number of artifacts and their lack of retouched surfaces supports the possibility that the artifacts are of Lower Palaeolithic age. Continuing excavations will certainly help to clarify and amplify these interpretations.

Preliminary Conclusions concerning Kao Pah Nam

Preliminary results indicate that the Kao Pah Nam fauna is probably of at least Middle Pleistocene age. Several species of mammal as well as Testudinae and snakes are present at the locality (see Table 1). While identification and study of the mammalian remains recovered from the site is still in a preliminary stage, it is already apparent that primates *(?Pongo), Hystrix,* carnivores *(Crocuta* and *Panthera),* a large *Bos* (Plate VII), cervids, *Hippopotamus,* and other taxa occur in the breccia. On faunistic and geological grounds Kao Pah Nam is probably of at least Middle Pleistocene age and similar to contemporaneous assemblages from China (Pei 1957*a,* 1957*b,* 1958, 1962). This locality thus becomes one of the oldest and largest single localities to yield mammalian remains in Mainland Southeast Asia.

The age of Kao Pah Nam fauna is estimated on the basis of both geologic and faunistic data obtained during this year. A preliminary estimated age of at least .69 mya (Macdonald and Macdonald 1977) is suggested by the locality's position in relation to the palaeomagnetic Lampang basalt and the lack of any basalt in cave breccia (see geological section). The faunal composition of the Kao Pah Nam breccia includes a characteristically Middle Pleistocene suite of taxa, some never before reported from Thailand. A serious difficulty in arriving at dependable age estimates is the virtual lack of a continuous biostratigraphical sequence for Southeast Asia. Continued work at Kao Pah Nam will not only allow us to greatly augment the number of known fossil taxa from Thailand, but is also providing the first indications of the possible presence of hominids of at least Middle Pleistocene age in Mainland Southeast Asia. Further research here will allow us to expand upon these initial and important discoveries which have come to light at this locality.



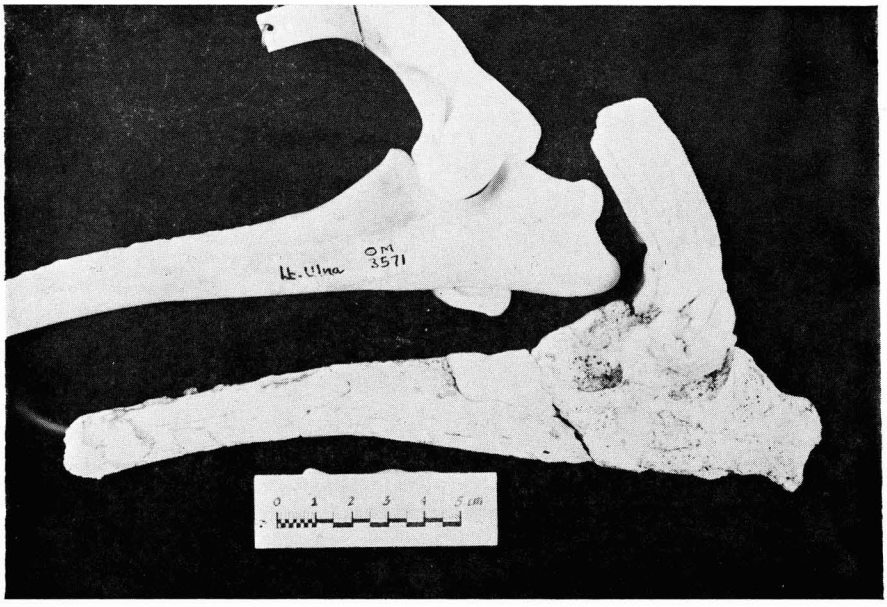


Plate V Modern *Crocuta* sp. Right and left p^4 *(top)*; left ulna and fossil distal radius *(bottom)*.

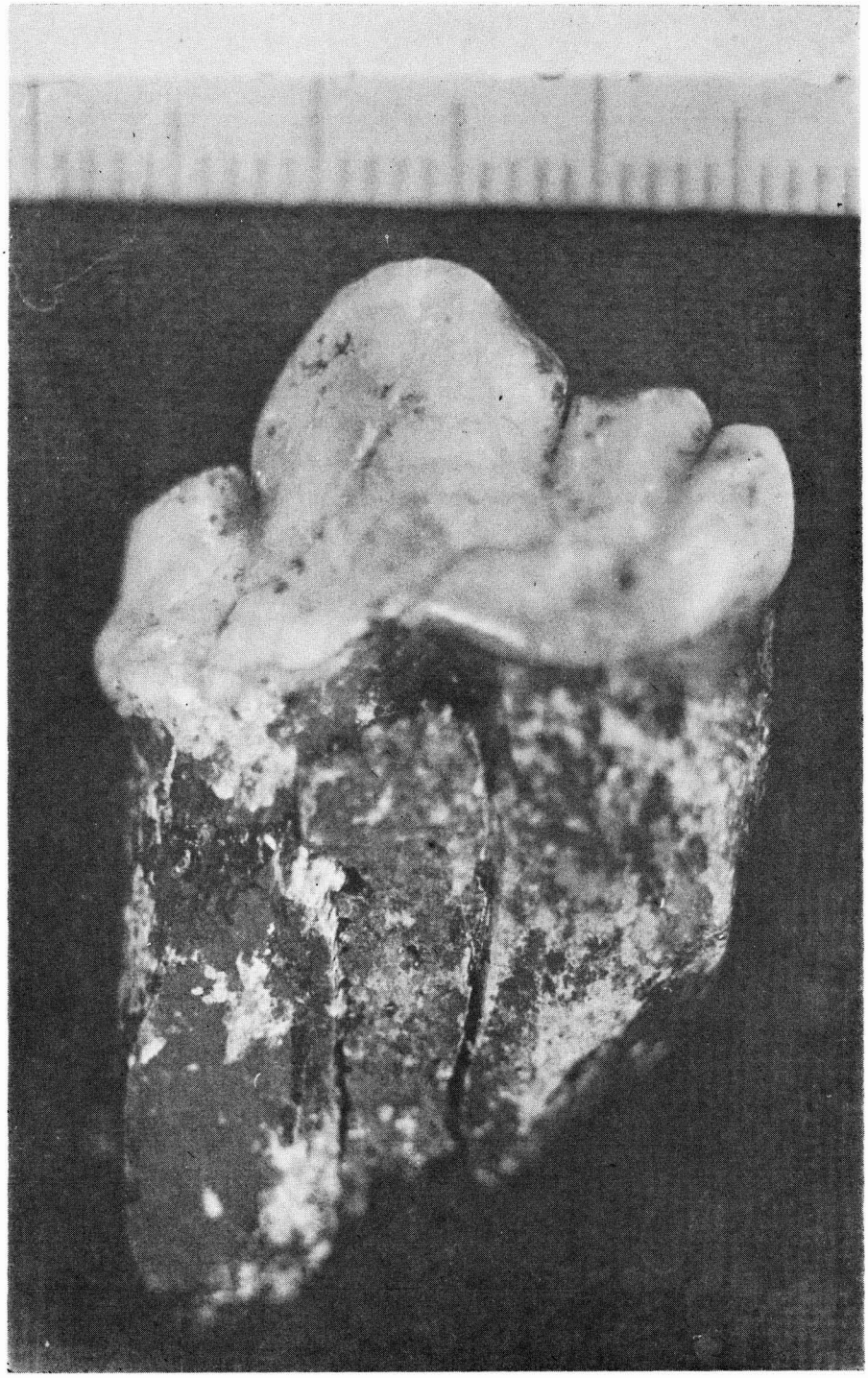
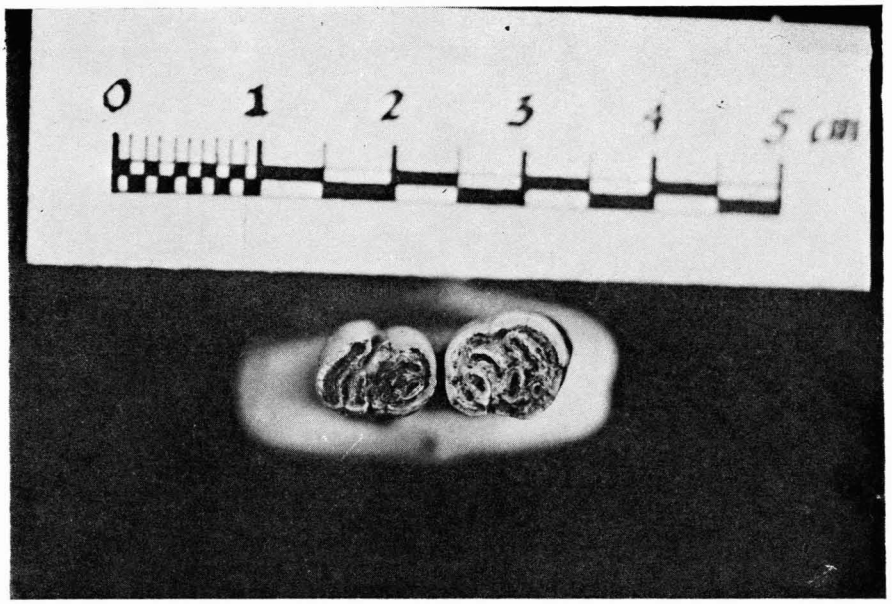


Plate VI Left P^4 of *Panthera tigris* recovered from soil pocket.



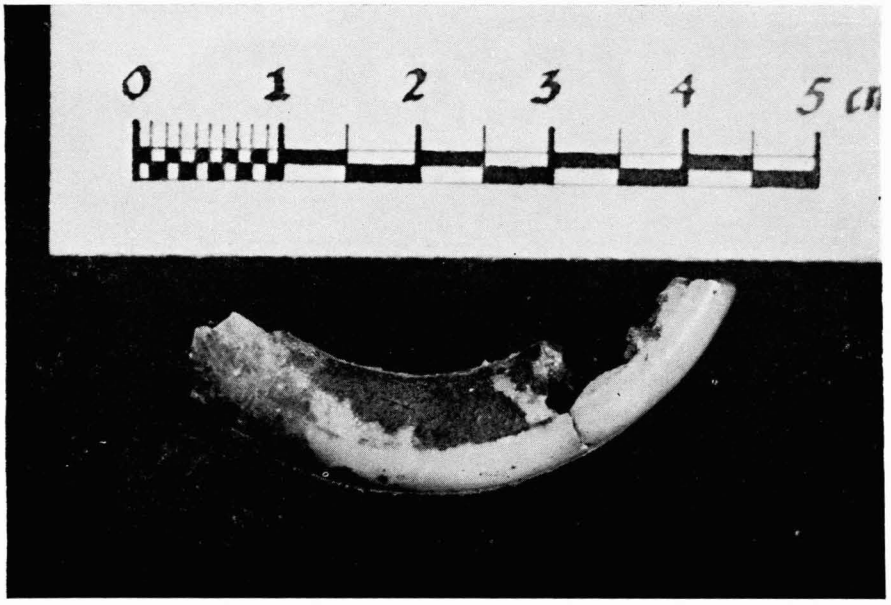


Plate VII *Hystrix* sp. molars and incisors recovered from soil pocket.

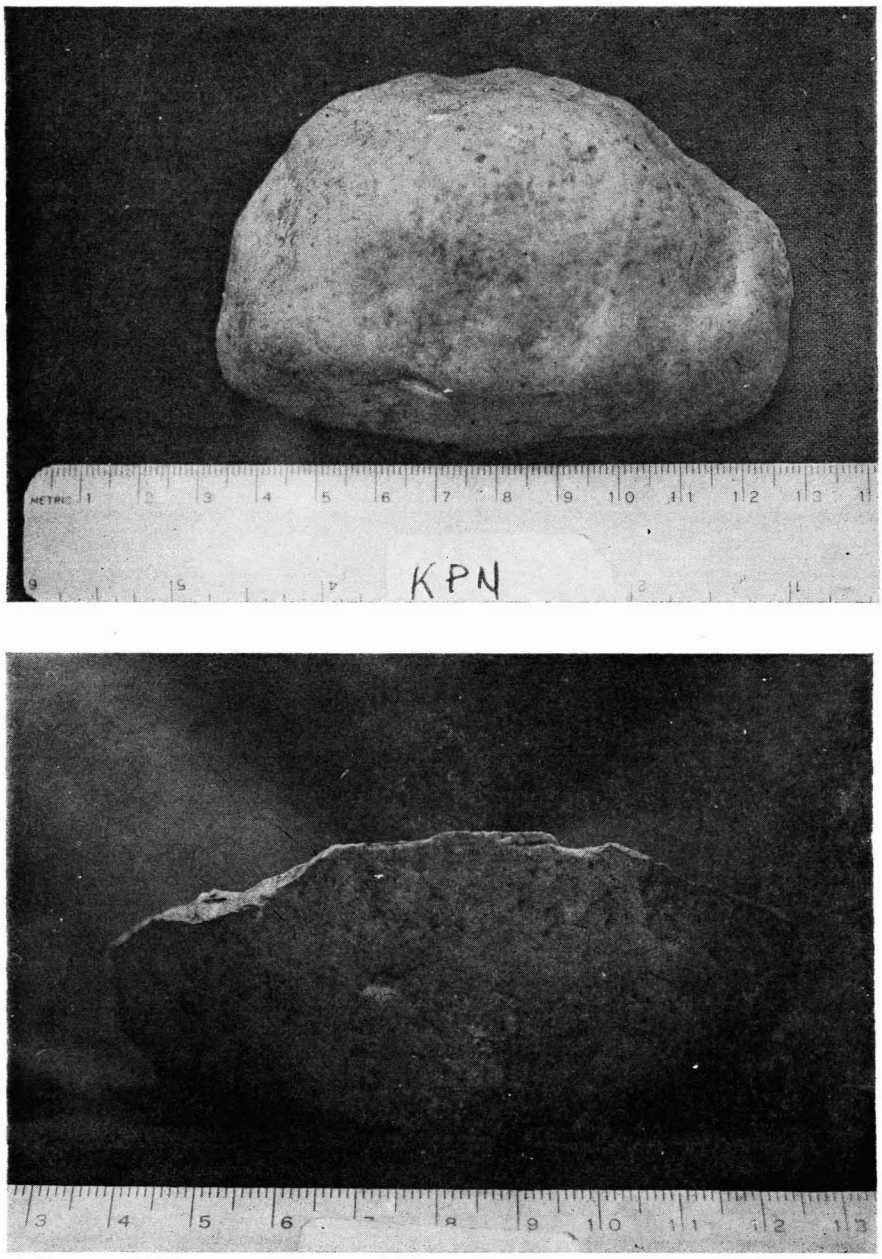


Plate VIII Split quartzite cobble (KPNA-1).

Plate IX Trapezoidal indurated sandstone cobble showing bipolar flaking (KPNA-2).

Plate X Possible "sawed" or "chopped" bone (KPNA-4).

THE STATE OF PALAEOANTHROPOLOGICAL RESEARCH IN NORTHERN THAILAND

Our recent research efforts have done much to clarify and partially answer some of the important questions about the scope and timing of hominid evolution in Southeast Asia. The complexities of trying to document human evolution in this area of the world over the last two million years demand the application of an interdisciplinary approach to modern anthropological researches. The dating, the palaeoenvironmental context (including palaeontology and palaeobotany), and the geological setting (including the deposition and preservation of fossil materials) are interrelated and overlapping spheres of inquiry which must be considered simultaneously in any attempt to reconstruct the evolutionary and biogeographic history of Asian hominids. It is useful here to consider some of the specific questions and approaches which have arisen as the result of past and continuing researches in Southeast Asia.

Biogeography

1. *Hominids*

As mentioned previously, Thailand occupies a place of central geographical importance in the known distribution of tropical Plio-Pleistocene Hominidae. The early Pleistocene occurrence of early species of the genus *Homo* (i.e., *Homo modjokertensis*, "*Meganthropus*," and "*Pithecanthropus*") comparable to contemporary African hominids (Tobias and Koenigswald 1964) and certain aspects of mammalian biogeography (i.e., the apparent first appearance of *Equus* in Africa and the first appearance of *Elephas planifrons* in Asia 2 mya) suggest that faunal interchange was occurring across the palaeotropics during the early phases of the Pleistocene. The presence of early grades of *Homo* in southern and central China during this same time strongly suggests that comparable grades of *Homo* must also have been in central Southeast Asia. The oldest previously known indication of hominids in Mainland Southeast Asia has been reported from Lampang (Sørensen 1976). Currently, evidence bearing on the evolutionary transition of a *Homo* sp. ("*Homo habilis*" of authors) grade of hominid to a *Homo erectus* grade of hominid is based largely on the abundant African record from this time period. Opinions about the geographical origin of these early grades of *Homo* as well as hypotheses about the ecological significance of both morphological and behavioral trends must remain necessarily constrained in the absence of comparable Asian data.

2. *Mammals*

In addition to the recovery of early hominids from Asia, many intrinsically interesting questions about the biochronology and palaeogeographic distribution of species belonging to the "*Stegodon-Ailuropoda* faunal complex" (the "Siva-Malaysian and Sino-Malaysian fauna" of authors) can be answered through the recovery of fossil faunal assemblages in Thailand. The actual palaeogeographic distribution of many taxa associated with hominid- and primate-bearing faunal assemblages not only bears on the task of palaeoenvironmental reconstruction, but also on the correlation of many important faunal localities. Apparent temporal fluctuations observable in the taxonomic composition of Javanese, Burmese, and

Chinese faunas throughout the Pleistocene have resulted in the ordering of Oriental faunas into an Early Pleistocene Siva-Malaysian complex and a Middle Pleistocene Sino-Malaysian complex (Colbert and Hooijer 1953; De Terra 1943). Research in Thailand offers an excellent opportunity to test the usefulness of this concept. A comparison of the fluctuations in the compositions of Thai faunas with other localities will provide an invaluable source of data from the geographic center of this faunal region. Because of the location of Chiang Mai and Lampang between the Northern Shan-Yunnan Massif and the now submerged Sunda Shelf, it is also possible to test the nature of the "faunal filters" that may account for the disjunct geographical distribution of many Pleistocene taxa. The distribution of such taxa as *Equus* (present in China, India, and Burma, but absent from islands of the Sunda Shelf), *Ailuropoda* (present in China and Burma only), *Gigantopithecus* (present in China only in the Pleistocene), and *Macaca* (present in the Early Pleistocene of Java and the Middle Pleistocene of China and Java) will also facilitate a much more complete understanding of the palaeogeography and environment which effected the movement of hominids and other mammals in Southeast Asia.

Karst Caves

Dating

Although final conclusions about the age of recovered materials will have to await detailed study of the fauna and correlation with palaeomagnetically studied sequences in nearby Lampang, the height of the first cave (Doi Tam locality) above the base of the karst tower suggests an early Pleistocene or middle Pleistocene age for the recovered materials. This is based on studies conducted on the karst tower faunas from South China and should be considered as no more than a preliminary estimate (Pei 1957*a-b*, 1962; White 1975). Tam Long and Tam Long South occur at much lower levels and have correspondingly less consolidated breccia. Incomplete fossilization and replacement of bone is observable in some of the specimens from these localities.

Work at Kao Pah Nam has further emphasized the complexities of interpreting the depositional and preservational histories of fossiliferous breccia deposits. Well-fossilized bones occur in very hard, well-consolidated breccia and in relatively loosely consolidated soil with no apparent taxonomic difference in the two zones. Further studies emphasizing the difference in the nonsoluble mineral contents of the two sediments will greatly aid in clarifying the relationship between them. Preliminary age estimates for the site also suggest that previous theories about the formation and deposition of fossils in karst caves may have been too simplistic.

Geomorphology and Taphonomy

Preliminary observations on the geomorphology of the fissures and the deposition and subsequent exposure of the fossiliferous breccia suggest new interpretations about the accumulation of fossiliferous karstic infillings. All the caves which were found to occur at ground level in the Chiangwat Chiang Mai area exhibited entrances which sloped toward the interior of the caves. All (with one exception) of those occurring more than 40 m above local valley streams exhibited floors which were either nearly horizontal or sloped down and out of the cave mouth. Those occurring

at 60 m and above (with two exceptions) exhibited floors which also sloped out of the cave mouth. This seems to have important implications for the mode of deposition of the fossil materials and suggests that water transport was a major taphonomic agent responsible for the deposition of the fossil materials. Additionally, it now seems likely that subsequent lowering of the local base level results in the erosion and removal of cave breccia which was originally deposited while the solution cavity was at (or below) ground level. All deposits located during the initial field season occurred inside side clefts of fissures.

These previous investigations have implications for the Kao Pah Nam site since this well-cemented breccia occurs at the base of the karst tower. Some of us (Pope and Kulasing) have suggested that the lowering of the local base level proceeded relatively slowly around Kao Pah Nam and that the downcutting activity of the nearby Wang River was severely restricted at some time during the Pleistocene. Whether this postulated lack of significant downcutting resulted from climatic or local tectonic changes is not clear at this stage. Both factors may be involved.

The most controversial debates about the karst cave faunas of southern China have focused on the nature of taphonomic agents responsible for the presence of large mammals, especially primates, such as *Homo* (*Australopithecus* of Hu 1973), *Gigantopithecus, Pongo, Hylobates,* and *Macaca.* The collecting habits of *Hystrix,* carnivore activity, and water transport have all been advanced as prime taphonomic agents responsible for these fossil assemblages (see White 1975 for a review of these arguments). Unfortunately, the great majority of Chinese sites have been destroyed by "dragon bone miners" and fertilizer diggers. Those that have been systematically excavated have not been the subject of rigorous taphonomic studies. The numerous karst caves of the Chiang Mai area are almost completely undisturbed and have never been the subject of "dragon bone" hunts. The recording of orientation of fossil materials, the age composition of the assemblages, sedimentology of surrounding matrix (i.e., sorting, presence of authigenic minerals, and flow features), and the conditions of preservation (including marks attributable to carnivore activity) represents the only practical means of developing a true understanding of Asian karstic faunas from South China and surrounding countries (see Voorhies 1969 for specific field techniques).

Palaeoenvironmental Reconstruction

Palaeoenvironmental studies can also be profitably pursued in the Chiang Mai area through the interpretation of vertebrate fauna and through the study of floral and palynological data. Microfauna is abundant in many of the cave breccias examined in the Chiang Mai area. The existence of modern karstic topography in areas ranging from lowland to mountain habitats provides an excellent source of comparison for recovered fossil fauna and floral specimens.

The understanding of the palaeoenvironmental setting around Kao Pah Nam is still incomplete, to say the least. But on the basis of current studies, it is quite possible that the Wang Valley was as dry or drier than it is today. The presence of *Hippopotamus,* hyaenids, large cervids, and bovids as well as the apparent absence of gibbons may suggest a relatively open, dry diptocarp woodland surrounding an isolated karst tower. Any further conclusions must await the completion of palynological studies and the recovery of more faunal materials.

What we have learned as the result of recent researches is that northern Thailand is an area in which many fossiliferous caves occur. One of these localities, Kao Pah Nam, preserves the largest and perhaps oldest accumulation of fossil mammals yet recovered from a cave or rockshelter in Mainland Southeast Asia. Also as the result of artifacts collected at this locality, we know that hominids were active there. Carnivores and large rodents were active at the locality as well, and together with early hominids were probably major taphonomic agents responsible for the faunal accumulation discovered at Kao Pah Nam.

We feel that continued researches at Kao Pah Nam and other northern Thailand sites will greatly expand our knowledge of human evolution during the Pleistocene of Asia.

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